# On the Automatic Analysis of Learner Corpora

Modeling between surface features
and linguistic abstraction

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based on joint research with
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## Overview

- Motivations behind analyzing learner language
- Linguistic categories for learner language
- Experimentally exploring the space between surface-based features and linguistic abstractions
  → Native language classification

## Why Analyze Learner Language?

- Second Language Acquisition (SLA) research is aimed at understanding
  - how languages are acquired
  - and how language works
- empirical basis: analysis of learner data
  - Data collected in corpora can provide empirical insights for the development & validation of linguistic theories.
- Analysis of learner language data also helps document and advance our understanding of
  - student abilities and needs
  - teaching methods and tools

  in Foreign Language Teaching and Learning (FLTL) and Intelligent Computer Assisted Language Learning (ICALL).

## Learner Data in SLA Research

An example: Clahsen & Muysken (1986)

- They studied the acquisition of German word order by native speakers of Romance languages.
- Stages of acquisition:
  1. S (Aux) V O
  2. (AdvP/PP) S (Aux) V O
  3. S V[+fin] O V[-fin]
  4. XP V[+fin] S O
  5. S V[+fin] (Adv) O
  6. *dass* S O V[+fin]

  | | | | | |
  |---|---|---|---|---|
  | Stage 2 example: | *Früher* | *ich* | *kannte* | *den Mann* |
  | | earlier$_{AdvP}$ | I$_{S}$ | knew$_{V}$ | [the man]$_{O}$ |
  | Stage 4 example: | *Früher* | *kannte* | *ich* | *den Mann* |
  | | earlier$_{AdvP}$ | knew$_{V[+fin]}$ | I$_{S}$ | [the man]$_{O}$ |

- How is the data characterized?
  - *lexical* and *syntactic categories* and *functions*
  - some acquisition stages are well-formed, others ill-formed

# Corpus Annotation for SLA Research

- SLA research essentially observes the occurrence and correlations of linguistic properties
- Corpus-based research can make use of linguistic annotation to support the identification of
  - characteristic, criterial features of language development (e.g., Hawkins & Buttery 2010)
  - quantitative measures of language development **C**omplexity, **A**ccuracy & **F**luency (Housen & Kuiken 2009)
  - overuse/underuse of linguistic material (Wiersma et al. 2011, Hirschmann et al. 2010)

⇒ What is involved in linguistically annotating learner corpora (automatically)?

# Annotation of Linguistic Properties

- Annotation schemes for native language corpora have been developed for a wide range of linguistic properties:
  - part-of-speech, morphology
  - syntactic constituency, lexical dependency structures
  - semantics (word senses, coreference), discourse structure
- An annotation scheme is only as good as the distinctions it reliably supports making based on evidence in corpus.
  - E.g., particle vs. preposition dropped in PTB tagset
  - More classes can actually be more reliable if they are more coherent in terms of their observable properties.
    - cf. BNC Tag Enhancement Project (CLAWS7 ↦ CLAWS5)
- Which linguistic categories are
  - appropriate for learner language,
  - relevant for answering research questions,
  - and can be reliably annotated?

# Appropriate categories for learner language

Parts-of-speech (Díaz Negrillo, Meurers, Valera & Wunsch 2010)

From the NOSE learner corpus (Díaz Negrillo 2009):

(1) *RED helped him **during** he was in the prison.*
- stem: preposition
- distribution: conjunction

(2) *you can find a big **vary** of beautiful beaches*
- stem: verb
- distribution: noun

(3) *one of the favourite places to visit for many **foreigns**.*
- stem: adjective
- distribution, morphology: noun

(4) *to be **choiced** for a job*
- stem: noun or adjective
- distribution, morphology: verb

# Systematic POS for Learner Language

- A single POS tag from a standard native tagset fails to systematically identify properties of learner language.
- Better: tripartite POS encoding of observable properties
  - distribution, stem, morphology

  → supports identification of mismatches in linguistic encoding
- The value of identifying such mismatches systematically is confirmed by recent SLA research (Zyzik & Azevedo 2009)
  - L2 learners are shown to have
    - difficulty distinguishing between word classes among semantically related lexical forms
    - limited ability to interpret syntactic and morphological cues

# On the nature of categories for learner language

- Annotating learner language with the standard annotation schemes developed for native language can hide important learner language characteristics.
- Comparative fallacy: “the mistake of studying the systematic character of one language by comparing it to another.” (Bley-Vroman 1983, p. 6)
- Essentially trying to analyze a “non-canonical variety” using a “robust” version of the canonical grammar.
  - divergences from norm annotated as errors
- Issue more general than language acquisition research:
  - Eurocentrism in field work (Gil 2001)
  - Variationist sociolinguistics:
    - Importance of defining variation to be studied and when exactly an instance is counted as one of the variants.

# On the nature of categories for learner language

## Between representing variation and robustness

- Where do linguistic categories come from?
  - Categories result from generalizations, which require a significant amount of comparable data to be made.
- How fine grained should they be?
  - The category system used must be sufficiently fine grained for the variation we want to identify and analyze.
  - Robustness needed to *ignore* other variation in the realization of a category to be identified.

→ To provide access to the right level of abstraction for a range of research questions: multiple levels of annotation

# On the nature of categories for learner language

## Consequences for syntactic annotation

- Idea: break down constituency in terms of
  - overall topology of a sentence (Hirschmann et al. 2007)
  - chunks (Abney 1997)
  - dependencies
    - dissociation of morphological, syntactic, and semantic dependencies (cf. also Meaning Text Theory, Mel’čuk 1988)
- Dependency analysis of learner language:
  - surface-evidence based (Dickinson & Ragheb 2009)
    - goal: fine-grained record of morphological & syntactic evid.
  - canonical dependencies (MacWhinney 2008; Rosén & Smedt 2010; Ott & Ziai 2010; Hirschmann et al. 2010)
    - goal: robustly abstract away from learner specific forms
    - e.g., in CoMiC: robust construction of semantics for comparing the meaning of answers to reading comprehension questions (Hahn & Meurers 2011)

# On developing an experimental testbed

- How can we find out more about the informativeness of the surface forms and linguistic abstractions?

  → Set up a classification experiment which allows us to quantify impact of different features.
- An interesting candidate:
  Identifying the native language (L1) of a non-native text.
- *Transfer is the influence resulting from similarities and differences between the target language and any other language that has been previously [. . . ] acquired.* (Odlin 1989, p. 27)
  - L1 Transfer occurs at many levels:
    lexical, syntactic, discourse, . . .

# Two strands of experiments

- Data-driven approach with Serhiy Bykh:
  - from surface forms to part-of-speech
- Theory-driven approach with Julia Krivanek:
  - syntactic alternations (Levin 1993) as a linguistic perspective on the data

# Data-driven approach with Serhiy Bykh

## Corpus used

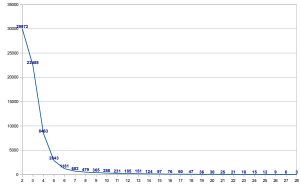
- International Corpus of Learner English (ICLE V.2, Granger et al. 2009)
  - argumentative essays written by higher intermediate to advanced learners of English, several mother tongues
- Used a subcorpus with seven native languages:
  - Bulgarian, Czech, French, Russian, Spanish, Chinese, Japanese
- 95 texts per language
  - 70 for training, 25 for testing
  - each text is between 500 and 1000 words long

⇒ For each text in the test set, determine the native language of the writer.

# Approach 1

## Setup

- efficiently identify all recurring surface forms
  - cf. variation n-gram approach to corpus annotation error detection (Dickinson & Meurers 2003, 2005; Boyd et al. 2007, 2008)
- extract all sequences of words (n-grams) which occur in at least two essays of the training corpus
  - 67.905 n-grams of length 2–28



# Approach 1

## Example features

- 2-grams: *aspect of, europeans but, would reduce, becoming the, teacher without, ago he, the team, see to, tv and, hunt and, into debts*, . . .
- 3-grams: *that smoking is, is capable of, of what they, real world the, leaves much to, of so called, their health and, to know and, need for a, difficult to accept*, . . .
- . . .
- 15-grams: *breathing secondhand smoke increase the risk of lung cancer and heart disease by about 25, dominated by science technology and industrialisation there is no longer a place for dreaming and* , . . .

# Approach 1

## Results

- We trained an SVM classifier (LIBLINEAR, Fan et al. 2008) on the 490 essays in the training set and tested on the 175 documents in the test set.
- use each recurring n-gram as a binary feature:
  - 1 if it occurs in the text, 0 if not
- Result: 87,4% accuracy of classification
  - Random baseline for seven language classes: 14.3%
  - Wong & Dras (2009): 73.7%
- What happens if we abstract away from the words within each n-gram feature
  - to words with the same part-of-speech?
  - to any words occurring there?

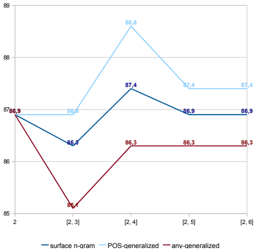
# Approach 1

## Example POS-generalized features

- 3-grams: *each JJ it, environment IN which, and DT which, family RB at, a NN this, few NNS later, attract JJR people, each JJ in, number IN crimes, imagination NN is, way CC have, on DT day*, . . .
- 4-grams: *they VBP IN the, for JJ NN to, different NNS IN view, pros CC NNS in, would VB RB longer, all IN DT we, while PRP VBP young, heart NN IN about, is DT RBS significant, in DT NN market*, . . .

# Approach 1

## Overall results



- Generalization to POS classes improves result, whereas non-linguistic generalization does not.
- Success, but it is hard to qualitatively interpret features in terms of L1 transfer!

# An alternative

- Word-based surface features always encode form and meaning together.
  - requires very high number of features to be applicable to unseen data, across domains/topics
- Can we abstract away from the meaning to be expressed to choices in the linguistic system?
  - Idea: Study where the linguistic system provides multiple ways to express the same meaning.
    - similar to variationist sociolinguistics (though typically based on pronunciation variation, lexical choice there)
- How about valence alternations (Levin 1993)?
  - e.g., Dative Alternation

    (5) a. *He gave the book to John.*

    b. *He gave John the book.*

  - Popular topic in linguistics, but so far little corpus-based SLA work (but cf. Callies & Zaytseva 2011).

# Theory-driven approach with Julia Krivanek
## Setup

- Corpus used:
  - L1 Chinese from ICLE (V.2, Granger et al. 2009)
  - native English essays from LOCNESS (http://www.uclouvain.be/en-cecl-locness.html)
- Goal: binary classification into non-native vs. native
  - training: 600 documents, evenly split
  - testing: 120 documents, evenly split
- We focused on 21 alternation which can be reliably identified given syntactic annotation.
  - about 1/5 of the ones given in Levin (1993)

# Theory-driven approach
## Identifying alternations

- Easy to identify: *as*-Alternation

(6) a. *He appointed him press secretary.*
appoint + NP + NP
b. *He appointed him as press secretary.*
appoint + NP + PP(as)

- More difficult to identify: Simple Reciprocal Alternation

(7) a. *Anna agreed with John*
b. *Anna and John agreed.*

(8) *# Anna agreed with the argument.*

→ additional information (e.g., animacy) relevant

# Theory-driven approach
## Results

- syntactically annotated corpus with Bitpar (Schmid 2004)
  - trained on enriched WSJ from PennTreebank
  - → lexical categories contain subcategorization information
- identify syntactic alternations using tgrep2 patterns
- 21 binary alternations: 42 features per document
- features: choices per class made in a document
  - for each class, record relative frequency of choices
  - e.g., for document with 3 instances of a class: $\frac{2}{3}$, $\frac{1}{3}$
- 63.33% Accuracy (SVM: Weka SMO)
  - average document length only 790 words
  - not enough instances of relevant patterns per document!
  - when pooling 5 documents (120 train, 24 test): 70.83%

# Theory-driven approach
## . . . with a data-driven twist

- for each verb, record its selection patterns in the corpus
  - define classes consisting of all verbs with the same set of syntactic realization alternatives
- Corpora: L1 English (LOCNESS), L1 Chinese (ICLEv2)
  - training: 600 documents, evenly split
  - testing: 120 documents, evenly split
- Result: 72.5% accuracy (SVM: Weka SMO)
  - 87.5% when pooling 5 documents (120 train, 24 test)
  - 95.83% with alternative definition of verb classes

# Qualitative analysis of underuse/overuse

## Patterns

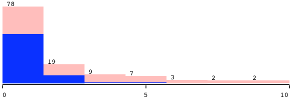
- overused in learner language: *provide* NP NP

  (9) *Universities provides us a chance to live.* (ICLEv2)

- underused in learner language: *see* NP *as* NP

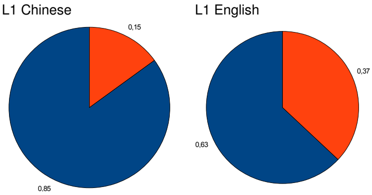
  (10) *Now we see it as being absurd in America that women did not have a right to vote.* (LOCNESS)

- general “V NP as NP” also underused by learners (blue)



# Qualitative analysis: distinctive alternations

## Locative Preposition Drop Alternation

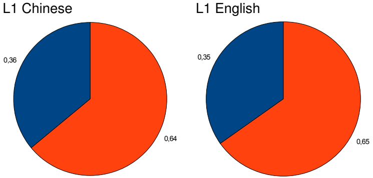


🟥 V-PPloc (Martha climbed up the mountain.)

🟦 V-NP (Martha climbed the mountain.)

# Qualitative analysis: indistinctive alternations

## Dative Alternation



🟦 V-NP-NP

🟥 V-NP-to-NP

# Conclusion (I)

- We started with sketching the role of learner language corpora in SLA and FLTL.
- Linguistic annotation is motivated by the need to support effective querying for relevant patterns.
  - Corpus annotation provides access to classes of data,
  - but annotated classes need to be appropriate for the type of language and research question at hand.
- The issue is particularly difficult for the individual interlanguage systems in language development.
  - standard annotation schemes can hide characteristics
  - need to balance robustness vs. variation to be captured
  - multilayer annotation useful to support range of research questions

# Conclusion (II)

- L1 classification as experimental sandbox for exploring impact of features between surface & linguistic abstraction.
  - Approach 1 with Serhiy Bykh:
    - data-driven: surface n-gram based
    - but: value of part-of-speech generalization
  - Approach 2 with Julia Krivanek:
    - theory-driven: alternation-based
    - but: value of data-driven class definitions
- General research direction:
  - Where can linguistic abstractions be shown to matter?
  - When does it pay off to identify a class or a rule instead of just storing all experience?

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